REMARKS

Claims 1-41 are pending in this application. All claims have been rejected under 35 U.S.C. § 103. No claims have been amended. Applicants submit that the following remarks fully address all issues raised in the Final Office Action and request withdrawal of the rejections based on these remarks.

35 U.S.C. § 103 Rejections

Claims 1-41 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of US Published Application No. US 2004/0096672 to Lukas et al. ("Lukas") and Cho et al. "Plasma Treatments of Molecularly Templated Nanoporous Silica Films," ("Cho") which was cited by Applicants in an Information Disclosure Statement. Applicants respectfully traverse this rejection.

Claims 1-24

Applicants invention relates to removing porogen from a dielectric matrix to create a porous dielectric film. Claim 1 requires both 1) exposing a precursor layer containing a porogen and a matrix to a plasma comprising a silanol capping agent, and 2) concurrently removing the porogen and protecting the matrix with hydrophobic groups.

As discussed in Applicants specification, conventional plasma-based porogen removal processes create "dangling bonds" (unsaturated SiO- or Si- groups) within the silicon-based dielectric matrix, which when exposed to ambient conditions, will react with moisture to create hydroxyl groups (page 3, lines 12-17). Applicants' invention has the advantage of concurrently removing the porogen and protecting the matrix with hydrophobic groups – a feature not taught or suggested by the art.

As discussed in the previous amendment, none of the cited references (Lukas, Cho or Birnbaum) teach or suggest either 1) exposing a precursor layer containing a porogen and a matrix to a plasma comprising a silanol capping agent, or 2) concurrently removing the porogen and protecting the matrix with hydrophobic groups.

Cho describes exposing the film to plasmas before and after the exposure to HMDS vapor; nowhere does the reference teach or suggest that the HMDS might be supplied in a plasma. Nor does Cho teach or suggest concurrently removing a porogen and protecting a matrix with hydrophobic groups.

Lukas teaches depositing a film containing structure-forming phase and a pore-forming phase on a substrate. In an "exposure" step following the deposition, the film is exposed to an energy source to remove the exposure step (see, e.g., paragraph 13). In some cases, a plasma is used as the energy source during the pore-forming phase. However, nothing in Lukas teaches or suggests that this plasma contains a silanol capping agent or that the structure-forming phase is protected. Rather the plasma removal in Lukas appears to be a conventional plasma-based porogen removal process that creates "dangling bonds" (unsaturated SiO- or Si- groups) within the silicon-based dielectric matrix.

The Examiner contends in the Final Office Action that the plasma of Lukas "implicitly contains a silanol [capping agent]," citing as evidence US Patent 6,548,113 to Birnbaum ("Birnbaum"), which shows the following dehydroxylation reaction: $R_3SiX_{(g)} + SiOH_{(s)} \rightarrow SiOSiR_{3\ (s)} + HX_{(g)}$. Assuming for the sake of argument that this reaction is a silanol capping reaction using $R_3SiX_{(g)}$, it is not conducted in a plasma. Applicants fail to see any suggestion or reason to believe that the porogen removal plasma of Lukas would contain $R_3SiX_{(g)}$, or that the porogen removal plasma of Lukas would protect the matrix with hydrophobic groups. The only comment that Applicants found in Lukas regarding the constitution of the porogen-removal plasma is that it may in a non-oxidizing environment (paragraph 55). There is no suggestion that it would contain (inherently) a silanol capping agent or that one should modify it to contain a silanol capping agent. As explained in Applicants' specification, conventional porogen-removal plasmas leave dangling bonds. There is no reason that one of skill would understand the porogen removal plasma of Lukas to contain a silanol capping agent or protect the matrix with hydrophobic groups.

Applicants further note that in the July 27, 2005 Office Action that Examiner stated that Lukas does not disclose applying a silanol capping layer to the matrix (page 3, item 4). If the Examiner is now relying on an implicit teaching in Lukas that the plasma contains a silanol capping agent (such as that shown in Birnbaum), Applicants request that the Examiner specify 1) where in Lukas it is taught or suggested that the plasma would contain a $R_3SiX_{(g)}$ compound or any other silanol capping agent, and 2) the mechanism by which the porogen-removing plasma of Lukas protects the matrix with hydrophobic groups.

Again, as indicated, conventional plasma based porogen-removal processes creates unsaturated Si- and SiO- groups within the dielectric matrix. It is the inclusion a silanol capping agent in a porogen removal plasma that in part distinguishes Applicants' inventions from the cited art.

Claims 25-41

Claim 25 also relates to a method of preparing a low-k dielectric material involving exposing a precursor layer containing an organic porogen in a dielectric matrix to a plasma to remove the porogen from the matrix. The claim recites "after removing said organic porogen, exposing the dielectric matrix to a silanol agent, without first exposing the dielectric matrix to moisture or ambient conditions." As explained in the specification, Applicants recognized the problems encountered in previously known processes, where care was not taken to prevent exposure of the dielectric matrix to moisture or ambient conditions after porogen removal and before exposure to a silanol capping agent. See e.g., page 3, lines 14-18 and page 15, lines 15-23.

Applicants submit that the claimed invention is patentable over the cited references at least because the claimed references, either alone or in combination, do not teach or suggest "after removing said organic porogen, exposing the dielectric matrix to a silanol agent, without first exposing the dielectric matrix to moisture or ambient conditions."

Because Lukas fails to teach or reasonably suggest exposing the dielectric matrix to a silanol capping agent, the Examiner presumably relies on Cho to supply the element "after removing said organic porogen, exposing the dielectric matrix to a silanol agent, without first exposing the dielectric matrix to moisture or ambient conditions."

While Cho may describe removal of porogen (oxygen plasma to remove organic template) and subsequent exposure to a silanol capping agent (exposing the film to HMDS vapor), the reference does not specify that exposing the dielectric matrix to a silanol capping agent occur without first exposing the dielectric matrix to moisture or ambient conditions. It should be noted that Cho specifies that after exposing the silica film to the HMDS vapor, the film is "then moved to the PECVD system," i.e., where the porogen removal took place (page G36, first column). This indicates that the after the organic template is removed, the film is removed from the PECVD chamber for exposure to HMDS vapor. There is no discussion of special procedures taken to assure that the silica film is not exposed to moisture or ambient conditions during the transfer or during exposure to HMDS vapor.

At least because the cited references do not teach or suggest "after removing said organic porogen, exposing the dielectric matrix to a silanol agent, without first exposing the dielectric matrix to moisture or ambient conditions," Applicants believe claim 1 is patentable over the cited art.

Applicants note that the Examiner has not identified the recited claims features in either of the prior refernces. If the rejection is based upon inherent disclosure of the recited claim features or upon some feature allegedly understood by those of skill in the art but not explicitly disclosed in the text of the reference, Applicants respectfully request that the Examiner make this clear and point to the source of the pertinent claim features in the Lukas and/or Cho.

In addition to being patentable for the reasons given above with respect to claim 25, dependent claims 26-41 contain features that are independently patentable. For example, claim 32 specifies that the silanol capping agent is provided in a second plasma. As discussed above with respect to claim 1, neither Lukas nor Cho teach or suggest providing a silanol capping agent in a plasma.

Withdrawal of the 35 U.S.C. § 103(a) rejections of claims 1-41 is respectfully requested.

Conclusion

Applicants believe that all pending claims are allowable and respectfully request a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,
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